DP-307786

IMPELLER FOR FUEL PUMP

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] The present invention claims the priority date of copending United States Provisional Patent Application Serial Number 60/396,771, filed July 18, 2002.

TECHNICAL FIELD

[0002] The present invention relates generally to fuel pumps for vehicles and, more particularly, to an impeller for a fuel pump.

BACKGROUND OF THE INVENTION

[0003] It is known to provide a fuel tank in a vehicle to hold fuel to be used by an engine of the vehicle. It is also known to provide a fuel pump to pump fuel from the fuel tank to the engine. One type of fuel pump is known as a high-pressure turbine or regenerative fuel pump. These pumps are used extensively in automotive applications due to their ability to generate high heads at small flow rates. These pumps are small and easy to manufacture, but they have a fairly low efficiency due to the tortuous path the fluid must follow as it moves from the inlet to the outlet.

[0004] Over the past few years, strong emphasis has been placed to make these fuel pumps more efficient. It is estimated that for every ampere of current drawn by these fuel pumps, the internal combustion engine efficiency degrades by one percent (1%).

[0005] In general, the high-pressure turbine fuel pump typically includes an impeller rotatable between an inlet plate, an outlet plate, and a spacer. The impeller has a plurality of vanes or blades positioned in the radial direction. If extended, these vanes or blades will pass through the center of the impeller. The fuel pump also includes peripheral channels machined in the inlet and the outlet plates. The fuel pump further includes a motor having a drive shaft to rotate the impeller.

[0006] In operation, as the impeller rotates, it imparts energy to the fluid trapped between the blades. As the fluid is pushed along a circular path, it is pushed in the tangential direction. Centrifugal force then causes the fluid to leave the impeller and enter the channels. The resulting motion of the fluid is that of a spiral. This process continues until the fluid encounters a blockage (called stripper) in the channels and it then exits through the outlet.

[0007] As the fluid moves in and out of the impeller, it loses energy due to entry and exit losses as

well as friction. The impeller must constantly supply energy to the fluid to overcome these losses.

[0008] Therefore, it is desirable to provide an impeller for a fuel pump that minimizes those losses as fluid particles enter and exit the impeller from a channel in a pump section of the fuel pump. It is also desirable to provide an impeller in a fuel pump for a fuel tank in a vehicle that improves the mechanical efficiency of the high-pressure pump section of the fuel pump. It is further desirable to provide an impeller for a fuel pump that draws a smaller amount of current. Therefore, there is a need in the art to provide an impeller for a fuel pump that meets these desires.

SUMMARY OF THE INVENTION

[0009] Accordingly, the present invention is an impeller for a fuel pump including a hub portion adapted for attachment to a rotatable shaft. The impeller also includes a plurality of blades extending outwardly from the hub portion and disposed circumferentially thereabout. The impeller further includes a peripheral ring portion extending outwardly from the blades to shroud the blades. The blades are non-radial relative to a center axis of the hub portion.

[00010] One advantage of the present invention is that a new impeller for a fuel pump is provided. Another

advantage of the present invention is that the impeller has a plurality of blades that are slanted or non-radial to improve the efficiency of the fuel pump. Yet another advantage of the present invention is that the impeller has non-radial blades to reduce friction losses as fluid particles enter and exit the impeller from a channel in a pump section of the fuel pump. Still another advantage of the present invention is that the impeller has non-radial blades that reduce the amount of current drawn by the fuel pump, thereby increasing the efficiency of the fuel pump. Still another advantage of the present invention is that the impeller minimizes friction losses and improves the overall mechanical efficiency of the pump section of the fuel pump. A further advantage of the present invention is that the impeller has slanted blades, thereby achieving higher flow for the fuel pump versus standard radial blades.

[00011] Other features and advantages of the present invention will be readily appreciated, as the same becomes better understood, after reading the subsequent description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[00012] Figure 1 is a fragmentary elevational view of a fuel pump, according to the present invention.

[00013] Figure 2 is a plan view of an impeller, according to the present invention, of the fuel pump of Figure 1.

[00014] Figure 3 is an enlarged plan view of a portion of the impeller in circle 3 of Figure 2.

[00015] Figure 4 is a sectional view taken along line 4-4 of Figure 3.

[00016] Figure 5 is a perspective view of an exploded portion of the impeller of Figure 2.

[00017] Figure 6 is a graph of hydraulic efficiency of the fuel pump of Figure 1 at various slant angles.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[00018] Referring to the drawings and in particular Figures 1 and 2, one embodiment of a fuel pump 12, according to the present invention, is shown. The fuel pump 12 includes a pump section 14 at one axial end, a motor section 16 adjacent the pump section 14, and an outlet section 18 adjacent the motor section 16 at the other axial end. As known in the art, fuel enters the pump section 14, which is rotated by the motor section 16, and is pumped past the motor section 16 to the outlet section 18. The outlet section 18 has an outlet member 20 extending axially with a passageway 22 extending axially therethrough. The outlet member 20 also has a plurality of projections or barbs 24 extending radially outwardly

for attachment to a conduit (not shown). The outlet member 20 also includes a check valve 26 disposed in the passageway 22. It should be appreciated that the fuel flowing to the outlet section 18 flows into the outlet member 20 and through the passageway 22 and check valve 26 when open to the conduit. It should also be appreciated that, except for the pump section 14, the fuel pump 12 is conventional and known in the art.

[00019] The pump section 14 includes an impeller 28, according to the present invention, mounted to a rotatable shaft 29 of a motor 30 of the motor section 16 for rotation therewith. The impeller 28 is generally planar and circular in shape. The impeller 28 has a hub portion 31 attached to the shaft 29 by suitable means (not shown). The impeller 28 also has a plurality of blade tips 32 extending radially from a hub diameter 33 of the hub portion 31 and disposed circumferentially thereabout. The impeller 28 has a peripheral ring portion 34 extending radially from the blade tips 32 to shroud the blade tips 32.

[00020] The pump section 14 also includes an inlet plate 35 disposed axially on one side of the impeller 28 and an outlet plate 36 disposed axially on the other side of the impeller 28. The inlet plate 35 and outlet plate 36 are generally planar and circular in shape. The inlet plate 35 and outlet plate 36 are enclosed by a housing 38

and fixed thereto. The inlet plate 35 and outlet plate 36 have an inlet or first recess 40 and an outlet or second recess 42, respectively, located axially opposite the blade tips 32 adjacent to the peripheral ring portion 34 to form a flow channel 43 for a function to be described. The recesses 40 and 42 are generally annular and allow fuel to flow therethrough from an inlet port (not shown) to an outlet port 44 of the pump section 14. The peripheral ring portion 34 of the impeller 28 forms an outside diameter (OD) sealing surface 46 on both axial sides thereof with the inlet plate 35 and outlet plate 36. It should be appreciated that the impeller 28 rotates relative to the inlet plate 35 and outlet plate 36 and the inlet plate 35 and outlet plate 36 are stationary relative to the impeller 28.

[00021] The pump section 14 also includes a spacer ring 48 disposed axially between the inlet plate 35 and outlet plate 36 and spaced radially from the impeller 28 to form a gap 50 therebetween. The spacer ring 48 is fixed to the housing 38 and is stationary relative to the impeller 28. The spacer ring 48 is generally planar and circular in shape.

[00022] Referring to Figures 2 through 5, the impeller 28 has a plurality of vanes or blades 52. Each of the blades 52 has an inner diameter, which corresponds to the hub diameter 33, and an outer diameter 54 and

extending between the inner diameter and the outer diameter 54. The blades 52 are generally "V" shaped. The blades 52 each have a trailing edge 56.

[00023] The blades 52 are non-radial. The blades 52 are slanted or angled a predetermined amount (θ), such as approximately -5.0 to approximately 20 degrees, more preferably 5.0 degrees from a radial line or axis 58 extending through a center axis 60 of the impeller 28. In the embodiment illustrated, the optimum back slant angle at which the efficiency is the highest is approximately five degrees (5°) relative to the radial axis 58 when a line 59 is projected from the trailing edge 56 of the blade 52. The blades 52 are slanted or non-radial, when extended, and will not pass through the center axis 60 of the impeller 28. The blades 52 each have a point of rotation 62 at the hub diameter 33 through which the radial axis 58 extends and the trailing edge 56 of the blades 52 is slanted by the predetermined amount (θ) by the line 59 projected from the trailing edge 56 and extending through the point of rotation 62. It should be appreciated that a plurality of blade cavities 64 are disposed between the blades 56. It should also be appreciated that fluid flows into the inlet recess 40 and through the blade cavities 64 and out the outlet recess 42. It should further be appreciated that, when the blades 52 are back slanted, as illustrated in Figures 2

through 5, entrance and exit losses are reduced and the fuel pump 10 becomes more efficient.

[00024] In operation of the fuel pump 12, the motor 30 rotates the shaft 29, which in turn, rotates the impeller 28 as indicated by the arrow. The fluid velocity created at the rotating surface of the outside diameter or surface of the peripheral ring portion 33 of the impeller 28 coupled with the viscous force gradient within the fluid cause the fluid such as fuel to flow. The fuel enters from the inlet port. As the impeller 28 rotates, it imparts energy to the fluid trapped between the blades 52. As the fluid is pushed along a circular path, it is pushed in the tangential direction. Centrifugal force then causes the fluid to leave the impeller 28 and enter the channels 43. The resulting motion of the fluid is that of a spiral. This process continues until the fluid encounters a blockage (called stripper) in the channels 43 and it then exits through the outlet port 44.

[00025] Without slant on the blades 52, the fluid recirculates between the impeller 28 and the channels 43 and turbulence at the tip may occur as the flow exits from the impeller 28, resulting in significant exit losses there. For that condition, the motor 30 must supply enough torque to the impeller 28 to overcome viscous force and the inertia of the fluid while the blades 52

experience pressure forces, which oppose the motion of the impeller 28.

[00026] In the present invention, the back slant on the blades 52 reduces these pressure forces and exit losses, thus making the transfer of energy more efficient. The net result is more flow and higher efficiency of the fuel pump 12. Figure 4 shows the hydraulic efficiency of the fuel pump 12 at various slant angles of the blades 52. It should be appreciated that there is an optimum angle of slant on the blades 52 at which the efficiency is the highest.

[00027] The present invention has been described in an illustrative manner. It is to be understood that the terminology, which has been used, is intended to be in the nature of words of description rather than of limitation.

[00028] Many modifications and variations of the present invention are possible in light of the above teachings. Therefore, within the scope of the appended claims, the present invention may be practiced other than as specifically described.